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# Comparative study between product- and service-based operations using time-driven activity-based costing

S N A M Zaini<sup>1</sup> and M Y Abu<sup>1</sup>

<sup>1</sup>Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang, 26600, Malaysia

**Abstract.** Product-based companies are consumer suppliers that can meet the customer order and consumption. Service-based operation is a company offering an intangible and non-including sales and satisfactions type of product. This work aims to summarize the strength of time-driven activity-based costing (TDABC) implementation in product- and service based operation using selected criteria. There are 8 criteria to be discussed are cost allocation, determination of drivers, transparency, cost consideration for implementation, transparency, overestimation of cost, oversimplification of activities and capacity forecast and planning. For product-based operation, this work is conducted at the plantation located in Prosper Palm Oil Mill Sdn. Bhd., Muadzam Shah, Pahang. The estate is divided into three main activity centers which are nursery, replanting and ramp. For service-based operation, data are taken from academic library in Universiti Malaysia Pahang, Pekan, Pahang. However in this work, only two activity centers are been used which are acquisition and cataloging. In this work, the application of TDABC in product- and service-based operations does not present any substantial differences in unused capacity. However, the activities in a product-based company depend on one another in terms of process dependence. While activities are independent in service-based operations.

## 1. Introduction

Product-based business is a company manufacturing goods which capable of fulfilling a customer demand, buying, use or consumption. Nevertheless, the product definition does not refer exclusively to tangible goods such as a car, a fridge or a telephone. As by the definition which product can also be offered for sale, it should be extended to include intangible products similar to the type of a service-based object. Palm oil is the largest in the worldwide market for edible oil traded in 17 major fats and oils. This makes an essential contribution to national agriculture for Gross Domestic Product (GDP), which generates RM 67.49 billion in 2018 [1] and is among the pillars of the Malaysian economy. The large variety of food and non-food products made from palm oils is globally recognized, mainly for their versatility. Service-based operation is a organization providing an intangible and non-including revenue, incentives and satisfactions special form of product. This is considerably narrowed down than the product description. Library managers must concentrate on valid data and financial projections about library practices. There are, for example, no tangible items and a range of resources available for main products in libraries other than scanning and copying [2]. Evolving of digital services, high information costs and constant financial constraints have intensified the libraries for efficiency and their need to provide high-quality services at lower cost [3]. Libraries as much as ever, must grow and continue to demonstrate their significance for academic management, which finds it



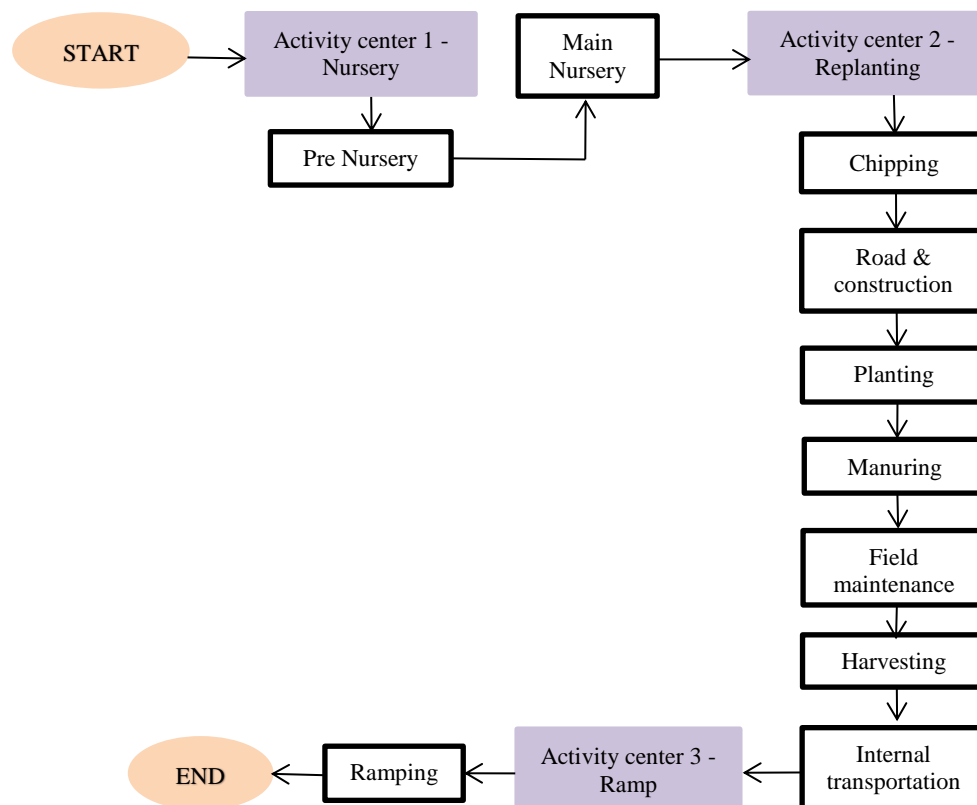
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difficult to comprehend new roles, costs and value. Although libraries know exactly what money they spent on each release, for instance, it is difficult to calculate the full cost of acquisitions and cataloging [4]. Inadvertently, it happened with a lack of financial understanding due to the insufficient costing system. Until just before the 1980s, conventional standard cost structures became less common, as the direct labour content of goods decreased. [5] suggested introducing a new economic model to generate good salary for community, growth and integration, leading to a higher standard of living. The application of the traditional approach on a specific basis, including direct working time leads to a less comprehensive and economic reality obviously not described. Cooper and Kaplan suggested costing methodology, Activity-based costing (ABC) which assumes different goods are using a range of resources and consume the same activities [6]. TDABC offers greater detailed understanding of system resources and its costs incurred when assessing processes and promoting performance improvement [7]. The method also precisely analyses the resources usage such as in the mature area, chipping has high insufficient capacity with RM-1,931,518.08 and internal transport has high waste cost with RM45,771.30 [8]. In evaluating processes and encouraging quality improvements, it provides deeper knowledge of operating tools and related costs [9]. Several works related to TDABC have been published. [10] reviewing the cost support features for comparison of the advantages of ABC and TDABC, and concluded that they are both powerful in line with the needs of the industry. The used and unused capacity in the production line were identified with TDABC in [11]. Station with overused capacity and multiple stations with underutilized capacity provides a simple summary of the company's management in order to enhance the investment plan. A comparative study was carried out between ABC and TDBAC on the electronic component [12]. The Mahalanobis-Taguchi system and TDABC are used in [13] to analyze process on production line in electrical and electronic industry. [14] proposed to assess key factors and develop a time equation and capacity cost rate in the electric and electronic industries by using the Mahalanobis-Taguchi system and TDABC. The TDABC method in the electrical and electronic sectors was implemented in [15]. The production costs for the magnetic part incurred in electrical and electronic manufacturing using TDABC have been measured [16]. TDABC was used in production costs of electronic parts [17]. The research gap of TDABC in journals which could be used as a reference to the implementation of the palm oil plantation was explored in [18].

## 2. Methodology

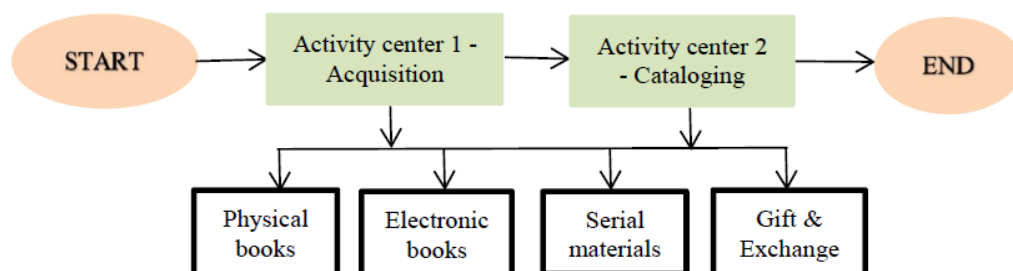
Several stages are applied in the TDABC. Using process mapping and all resources recorded, all activities and sub-activities are described. The time equation is then determined by identifying the cost driver in direct proportion to operating costs. The capacity cost rate is measured by estimating all the costs and the capacities currently used in the manufacturing process. Finally, the forecast is carried out by assessing the unused capacity in time and cost.

For product-based operation, this work is conducted at the plantation located in Prosper Palm Oil Mill Sdn. Bhd. which located in Muadzam Shah, Pahang. It has three main divisions and one of them is Simpai Division 1 Estate where the data of this research are collected. The estate is divided into three main activity centers which are nursery, replanting and ramp as shown in Figure 1. Then, each activities had been categorized into two main areas which are mature and immature. In the mature area, all plants are planted in year 1990 and 1991. For the immature area, the plants are planted in year 2015 and 2016.



**Figure 1.** The flow of work in Simpai Division 1 Estate.

For service-based operation, data are taken from academic library in Universiti Malaysia Pahang, Pekan, Pahang. There are four main principal functions that acts as main activity centers which are acquisition, cataloging, circulation and document delivery process. However in this work, as shown in Figure 2, only two activity centers are been used which are acquisition and cataloging. All activities had been categorized into local and oversea material.



**Figure 2.** The flow of work in UMP library.

### 3. Result and discussion

[19] concluded that TDABC is more suitable to be implemented in service-based operation. In order to construct comparative study between product- and service-based operation when implementing TDABC method, a review paper has been referred. There are 12 criteria that describe major differences between ABC and TDABC [20]. The criteria are cost allocation, determination of drivers, action taken for an additional activity, cost consideration for implementation, system building, system update, information given from each method, transparency, overestimation of cost, differentiation of service

level, oversimplification of activities and capacity forecast and planning. There are 8 criteria have been discussed in this work. However, there are four criteria that are abandoned in this discussion which are system building, system update, information given from each method and differentiation of service level as no specific information on this topic is given in the cited article. Below shows the selected 8 criteria and each explanation respectively.

### 3.1. Cost allocation

Only one stage for cost allocation is necessary for TDABC. In order to calculate the total cost, the total time used will be multiplied by capacity cost rate (CCR).

For product-based operation, the example is in activity center 1 nursery. The total time used for pre-nursery activity in mature area can be represented by 351,534 minutes. When multiplied by the CCR, RM0.45 per month, it can be determined that the total cost of this activity comes out as RM158,190.30 per month. Then, by adding all total cost in every activity centers in palm oil plantation which are nursery, replanting and ramp, the total utilization cost in mature area is RM6,041,995.10 and in immature area is RM55,591,587.73.

For service-based operation, the example is in activity center 1 acquisition. The total time used for physical books activity for local material can be represented by 7,051.01 minutes. When multiplied by the CCR of RM0.52 per month, it can be determined that the total cost of this activity comes out as RM3,690.37 per month. By adding all total cost in every activity centers in academic library which are acquisition and cataloging, the total utilization cost local material is RM47,667.61 and for oversea material is RM16,876.28.

### 3.2. Determination of drivers

TDABC handles each activity using a time driver and does not specify the driver for the property of the activity. To calculate the time used, a time equation is necessary. The estimated time for each activity is based on the study principles of Motion and Time.

In palm oil plantation, each estimated time taken for each sub-activities are same for both mature and immature areas. As in activity center 2 replanting, the maximum time taken for each round is in activity field maintenance of mature area, 133,313 minutes per round. In contrast, the minimum time taken is from activity manuring in immature area that took 0.05 minutes per round.

In academic library, each estimated time taken for every sub-activities are same for both local and overseas materials. The total time taken per round in activity 1 for both local and overseas materials are same which; physical books is 48,000 minutes, electronic book is 3,890 minutes, serial material is 1,005 minutes and gift and exchange took 9,125 minutes. From those four activities, it sum into a total of 18,860 minutes for every single round per month.

### 3.3. Consideration of an additional activity

The most significant insight is that while transactions can be easily challenging, managers can typically recognize what complicates them. The variables that influence most of these activities are often defined accurately and are usually already recorded in the information systems of an organization. The volume of cost drivers is then multiplied by time taken of each sub-activity for the development of the time equation.

For product-based operation, equation (1) and (2) are an example of the used time in activity center 2 replanting in mature area.

$$\begin{aligned} T_{\text{replanting(mature)}} &= 4X_{15} + 480X_{16} + 480X_{17} + 480X_{18} + 480X_{19} + 480X_{20} + 480X_{21} + 4X_{22} + X_{23} + 480X_{24} \\ &\quad + 0.75X_{25} + 8X_{26} + 2X_{27} + 0.083X_{28} + 46356X_{29} + 46356X_{30} + 40601X_{31} + 3X_{32} + 2X_{33} + X_{34} + 15X_{35} \dots \\ &\hspace{15em} (1) \\ &= (4 \times 46356) + (480 \times 200) + (480 \times 200) + (480 \times 200) + (480 \times 200) + (480 \times 200) + (480 \times 200) + \\ &\quad (4 \times 46356) + (1 \times 46356) + (480 \times 0.08) + (0.75 \times 92712) + (8 \times 92712) + (2 \times 92712) + (0.08 \times 46356) + \\ &\quad (46356 \times 0.08) + (46356 \times 1.5) + (40601 \times 3.25) + (3 \times 92712) + (2 \times 92712) + (1 \times 92712) + (15 \times 193.15) \end{aligned}$$

$$= 2,758,208.84 \text{ minutes (45,970.15 hours).} \text{-----}$$

(2)

For service-based operation, equation (3) and (4) are an example of the used time in activity center 2, cataloging for local material.

$$T_{\text{cataloging(local)}} = 2400X_{29} + 20X_{30} + 5X_{31} + 10X_{32} + 1440X_{33} + 1440X_{34} + 15X_{35} + 480X_{36} + 15X_{37} + 2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42} \text{-----} \quad (3)$$

$$= (2400 \times 2.17) + (20 \times 13) + (5 \times 13) + (10 \times 13) + (1440 \times 0.83) + (1440 \times 0.67) + (15 \times 72.67) + (480 \times 0.08) + (15 \times 0.75) + (2400 \times 1) + (20 \times 128.42) + (5 \times 128.42) + (10 \times 128.42) + (1440 \times 1)$$

$$= 17,289.05 \text{ minutes (288.15 hours).} \text{-----} \quad (4)$$

### 3.4. Informative

TDABC offers a greater insight into the profitability of the products and the usage rate of the capacity than in the Traditional Costing System (TCS).

Application of TDABC in product-based operation have been able to identify unused capacity which results in waste costs, or else insufficient capacity which causing incomplete cycle of plantation process. Overall, other than encountered to waste costs, most of the activities experienced insufficient capacity in form of manpower. The insufficient cost does not reflecting in parallel with the insufficient capacity due to difference varies of CCR of each sub-activity. For an example, the company need to hire more workers, especially for activity center 2 replanting, as activity planting seedlings have the highest insufficient capacity, 805,173.84 minutes and 566,934.84 minutes in mature and immature area respectively. However, within mature and immature area, the internal transportation activity incurs the highest amount of waste costs, at RM45,771.30 and RM29,667.472. Those workers should be deployed on another activity, one that does not have sufficient work capacity such as in planting seedlings stage, as this will help to reduce the amount of unused capacity and insufficient capacity. Other than that, in both areas there are activities that the amount of used capacity are almost to its provided practical capacity. In activity center 1 nursery, for main nursery activity of mature area, they utilized an additional of 793 minutes from its given capacity. In another hand, in activity center 3 ramp, for ramping activity in immature area have a vice versa result which there are balanced of 6,667.20 minutes from its practical capacity.

Meanwhile in service-based operation, TDABC implementation have proposed ways to reduce costs based on the analysis of capacity utilization in order to increase production capacity and decrease waste costs. This work is able to point out which activities that encounter unused capacity from its provided practical capacity which later ensue a sum of waste cost for academic library. Overall, other than facing to waste costs, some of the activities experienced insufficient capacity in form of manpower. It shows in local materials from both activity centers, acquisition and cataloging. In acquisition center, only electronic books activity come across to insufficient capacity of 862.05 minutes. Whereas in cataloging center, it is physical books with less 514.04 minutes and gift and exchange with less of 1,998.56 which is having the highest insufficient capacity compared to the other two. The number of staffs in both centers actually sufficient to manage all workloads. The only adjustment needed is by deploying a few staffs from another activity that have unnecessary unused capacity to the activity that demand extra manpower.

### 3.5. Overestimation of cost

There is no cost overestimation, as it allows for more precise results through the adoption of CCR in cost accounting to assess capacity utilization.

As an example for using CCR in product-based operation, in activity of pre-nursery in mature area, the CCR is RM12,237.41/27,360 minutes, or RM0.45 per minute.

Besides, as an example for using CCR in service-based operation, in activity of physical books for local material, the CCR is RM4,421.54/8,448.00 minutes, or RM0.52 per minute.

### 3.6. Transparency

TDABC is straightforward, as it indicates the duration of each operation. In any activity centre, the actual capacity used by each sub-activity can be calculated by multiplying the amount of round required for each sub-activity per month with total time taken for every round.

For product-based operation, in mature area, the total used capacity for activity center nursery, replanting and ramp are 407,047 minutes, 2,758,208.84 minutes and 55,672.20 minutes respectively. Then for immature area, the total used capacity are 287,854.50 minutes, 2,068,286.64 minutes and 34,372.80 minutes respectively.

For service-based operation, in local materials, the total used capacity for activity center acquisition and cataloging are 22,643.68 minutes and 17,289.05 minutes respectively. Then for overseas materials, the total used capacity are 18,144.17 minutes and 11,427.65 minutes respectively.

### 3.7. Oversimplification of activities

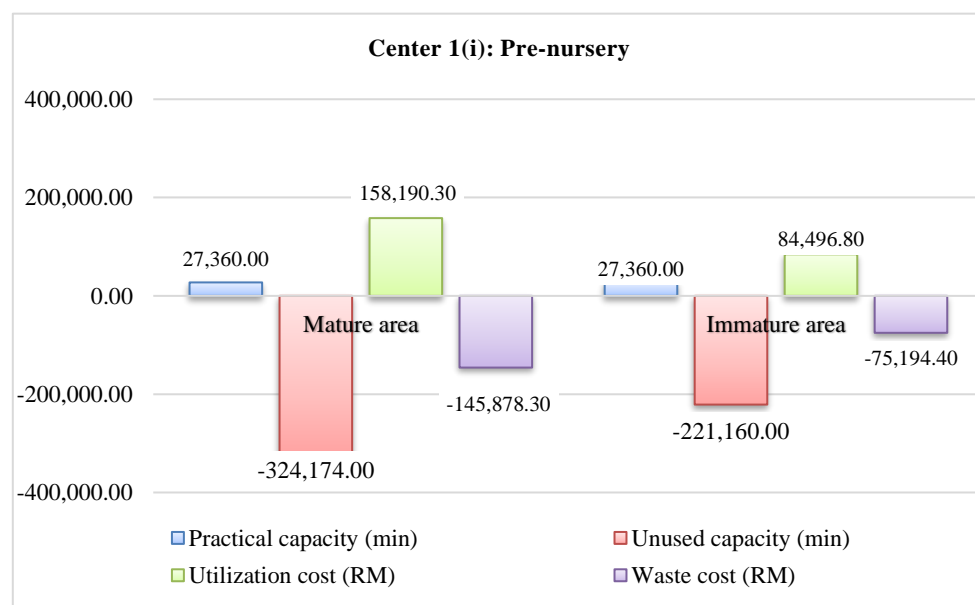
TDABC can use multiple cost drivers for an activity. As an example for product-based operation, in sub-activity pest and disease control of replanting center, the cost driver used is 3.25 rounds per month for both mature and immature area.

As an example for service-based operation, in sub-activity requesting quotation of acquisition center, the cost driver used are 10.25 and 4.50 amount of titles per month for both local and overseas materials respectively.

### 3.8. Capacity forecast and planning

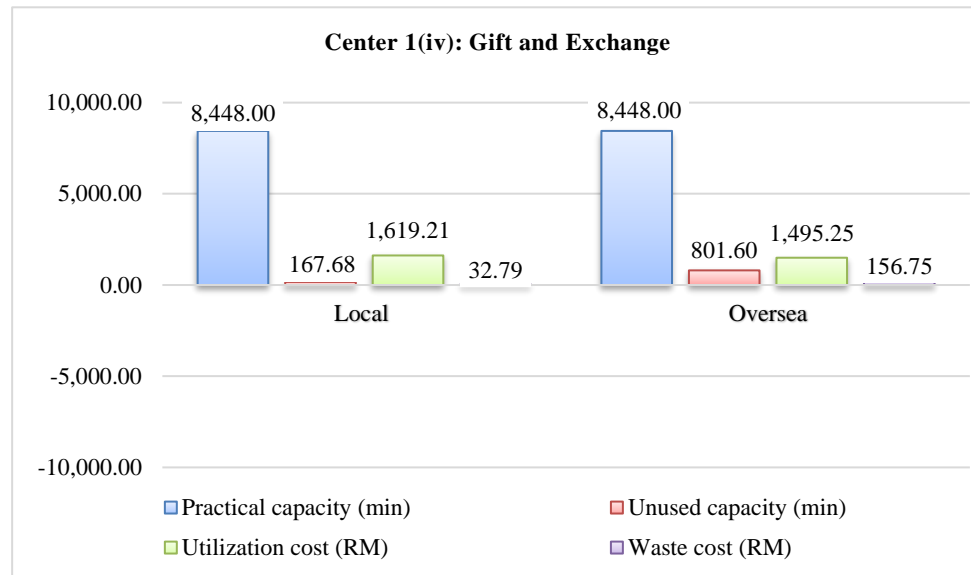
TDABC categorize resources used from those unused. Capacity utilization reference can be used to analyse the forecast. TDABC can thus be a benchmark for productive efficiency and provides proof of idle capacity. The unused capacity from the practical capacity provided will lead in waste costs and utilization cost associated with the used capacity.

As an example, Figure 3 shows the results in mature and immature areas for activity pre-nursery. Insufficient capacity in mature area is higher than in immature area with 103,014 minutes difference. To overcome the insufficient capacity, it needed an extra 324,174 minutes in mature area and 221,160 minutes in immature area.



**Figure 3.** Capacity utilization in activity pre-nursery.

As an example in Figure 4, it shows that unused capacity of gift and exchange in oversea material have higher value compared to in local material. Both 167.68 and 801.60 minutes must be reduced to eliminate waste costs of RM32.79 and RM156.75 in local and oversea materials accordingly.



**Figure 4.** Capacity utilization in activity gift and exchange (acquisition).

#### 4. Conclusion

In general, no major differences exist in the application of TDABC in product- and service-based operations in terms of unused capacity. However, activities in product-based operations are dependent on one another in terms of process dependency. While activities are independent in service-based operations. As a recommendation, this research work can be implemented in different research area regardless the type of operation to identify and further optimize the unused capacity.

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